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**THE EFFECT OF THE TRADITIONAL AFRICAN METHOD OF INFANT CARRIAGE ON THE POSTURAL, KINANTHROPOMETRY, ELECTROMYOGRAPHICAL, PROPRIOCEPTION, AND PULMONARY FUNCTION OF RURAL SOUTH AFRICAN FEMALES: CONCEPT**



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**ABSTRACT**


Background: Many rural South African females have the twin responsibility of cranial-loading water, food, and firewood while simultaneously carrying infants on their backs. There have been empirical studies identifying the harmful effects of cranial-loading on rural South African female posture, proprioception, and postural muscle activity. However, no investigations have been conducted on a South African cohort recording the incidence of neuro-musculoskeletal pain associated with infant carriage and/or the combined effect of cranial-loading and infant carriage on posture, kinanthropometry, postural muscle electromyography, proprioception, and pulmonary function. Method/Design: The studies will involve a cross-sectional pre-test post-test cross-over design. Participants will be indiscriminately allocated into the control (n=50) or experimental (n=50) group. The experimental group will carry the external load, while the control group will not. In the cross-over phase, the pre-test experimental group will become the control group carrying the external load. Participants' kinanthropometry and posture (craniohorizontal angle (CHA), craniovertebral angle (CVA), standing pelvic angles (SPA), and standing tibiofemoral angle (TFA)) will be measured during both phases. Electromyographical measures of participants' cervical and lumbar flexors and extensors will be recorded during the loaded and unloaded phases. The comparative analyses of loaded and unloaded pulmonary and proprioception responses will be examined. The research project involves four studies, which are progressively associated through external loading in different positions. Discussion: The findings of this research project will provide novel evidence, which will enhance the

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scientific and medical comprehension of the effect of posterior infant and cranial-loading on the health and well-being of rural South African females.

**Keywords:** Cranial-loading, rural, musculoskeletal, proprioception & pulmonary.

## INTRODUCTION

The lifestyle of females residing in rural African communities is one of suppression and hard labour. Rural females adopt numerous pivotal roles as mothers and caregivers in their family (Potgieter et al., 2018; Kurten et al., 2020). This study aims to review two aspects of the daily activities undertaken by females residing in rural African communities: the impact of cranial-loading and the impact of posterior infant carriage on the posture, kinanthropometry, Electromyographical activity, proprioception, and pulmonary function, of mothers, and / or surrogate care givers, residing in the I Lembe district.

There have been empirical investigations substantiating the ill-effects of cranial-loading on the health and well-being of rural African females. Echarri and Forriol (2002 & 2005) reported that daily head-loading has been associated with spondylolisthesis and herniated nucleus pulposus. Ellapen et al. (2009) as well as Kurten et al. (2021) concurred that cranial-loading does misalign sagittal plane posture. Kurten et al. (2021) reported that cranial-loading produces anterior pelvic rotation and pes planus. Motaung et al. (2022) documented that cranial-loading produces neuro-musculoskeletal pain, finding that the most vulnerable anatomical sites of neuro-musculoskeletal pain were the neck and lower back, which concurred with previous literature (Echarri & Forriol, 2002; Echarri & Forriol, 2005; Ellapen et al., 2009).

The practice of infant carrying is not a novel practice, which can be traced back to antiquity (Stevens, Patrick & Pickler, 2009). At the beginning of the 21<sup>st</sup> century, Western culture began to return to the traditional method of baby carrying, abandoning the baby stroller (Wax, 2004). Traditional infant carriage methods include wrapping the infant in cloth placed on the mother's back, side, and/or chest (Singh, 2009) with variations of the side carrying method including the placement of the infant in a basket. The handle of the basket is slung over the caregiver's shoulder, resting along the

mother's side. Singh (2009) stated that mothers and/or surrogate caregivers in rural Africa, Asia, and America favored carrying their infants on their backs (Loz off & Brittenham, 1979; Schon & Silven, 2007; Singh, 2009).

Across the African continent, laughing and/or sleeping babies are usually carried on their mothers' backs, enveloped in cloth (baby sling) (Wax, 2004). These infants are wrapped and gently swayed in to a sense of parental security by the rhythmic swaying of their mothers' hips, while their caregiver carries food, water, and firewood through cranial loading, sweeps the floor, and completes other domestic activities (Kurten et al., 2021). In rural Africa, mothers and/or surrogate caregivers traditionally carry infants wrapped in a cotton cloth called a capulana (Mozambican) and/or a kangas (Benin) (Wax, 2004).

Rural African mothers believe that carrying their infants on their backs illustrates their maternal affection towards their infants (Wax, 2004; Schon & Silven, 2007). These caregivers frown on using baby strollers, which is considered as being socially deplorable (Wax, 2004). Wax (2004), Ojukwu et al. (2017) and Van Eeden et al. Factors contributing to the musculoskeletal pain of infant carrying include carrying infants whose body mass exceeds 10kg, mothers older than 35 years, and caesarean birth (Ojukwu et al., 2017). Although Singh (2009) and Ojukwu et al. (2017) identified that African females who carry infants posteriorly experience lumbopelvic hip complex pain, the precise pathomechanics of the pain was undetermined, which warrants further investigation. This empirical research project aims to undercover the pathomechanics of the lumbopelvic hip complex pain which is experienced by mothers who make use of the traditional method of infant carrying.

A literature search in the Sabinet African Journal identified only two published studies (Singh, 2009; Ojukwu et al., 2009) reporting on African females who carry infants. One study was a descriptive report on the different methods of infant carriage (Singh, 2009) and the other was an empirical investigation on the incidence of musculoskeletal pain sustained by Nigerian caregivers (Ojukwu et al., 2017). This

sparsity of empirical research does warrant further investigation to initially confirm whether South African females who carry infants also experience any neuro-musculoskeletal pain and/or discomfort, and furthermore, to explore the pathomechanics of infant carriage as it leads to mother and/or surrogate caregiver musculoskeletal pain and discomfort. In South Africa, there is limited empirical studies that have been conducted documenting the effects of infant back carriage on the postural, biomechanical, kinanthropometrical, muscle activity, and health and wellness of mothers and/or surrogate caregivers. Reporting on such sparsely investigated focus area will provide novel knowledge, thereby serving as a guide to healthcare practitioners allowing them to draft preventive and rehabilitative neuro-musculoskeletal strategies as well as improve the quality of maternal life during child nurturing years. This research project is designed to investigate the following:

- i. The effect of the biomechanical and electromyographic changes caused by infant carrying among South African females residing in rural communities.
- ii. The effect of a front baby sling on the postural, kinanthropometrical, electromyographical, proprioceptive, and pulmonary function of rural South African females who traditionally carry infants on their backs.
- iii. The effect of head loading and back infant carriage on the posture, kinanthropometry, electromyographical muscle activity, pulmonary function, and energy expenditure of rural South African females who traditional carry infants on their backs.
- iv. A comparative analysis of posterior versus anterior infant carriage on the posture, kinanthropometry, electromyographical postural musculature, pulmonary and proprioception function of rural South African females.

#### **DESIGN OF THE STUDY**

The first of the four studies which comprise the research project will continue for approximately two years, with the principal goal of comparatively determining the impact of the African traditional posterior infant carriage method on posture, designated

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kinanthropometrical variables, and on postural musculature electromyographical voltage changes, in comparison to the unloaded state. In this study, the researchers will also be interested in documenting any incidence of neuro-musculoskeletal pain associated with posterior infant carriage.

The principal goal of the second empirical study is to determine the impact of the use of a different method of infant carriage (front facing) on mothers and caregivers in the I Lembe District. Their posture, kinanthropometry, as well as proprioception, together with any postural musculature electromyographical voltage changes will be measured and analyzed.

The principal goal of the third empirical study is to determine the impact of simultaneous posterior infant carriage and cranial loading on the posture, kinanthropometry, electromyography, and proprioception of mothers and surrogate caregivers in the I Lembe District.

The principal goal of the fourth study is to determine the comparative effect of anterior versus posterior infant carriage on the posture, kinanthropometry, electromyographical activity of the postural muscles, proprioception, and pulmonary function.

**RESEARCH DESIGN**

All four studies will involve an observational pre-test post-test cross-over design. A cross-sectional sample of mothers and surrogate caregivers in the I Lembe District will be secured. Ethical approval from the I Lembe Royal court and local community leaders has been secured. Prior to data collection, voluntary participant informed consent will be secured. All four studies will receive ethical approval from the Tshwane University of Technology prior to data collection. The Cochran formula was used to calculate the sample size, which has been calculated to be 95.4 and which was rounded up to 100 for convenience.

**PRE-TEST POST-TEST CROSS-OVER DESIGN**

Indiscriminate dissemination of participations into an experimental (n=50) or control (n=50) groups will be performed. The experimental group will carry their daily external load (loaded phase), while the control group will not (unloaded phase). In the cross-over phase, the pre-test control becomes the experimental group; they will then carry their daily external load (Figure 1). Conversely the pre-test experimental group will become the post-test control group. The external load in study one and two will be the infant that the mother and surrogate caregiver carries daily. In study three the external load will include the infant as well as the cranial load that the mother and surrogate caregiver carries. In study four, the change from anterior to posterior carrying position of the infant will serve as the intervention distinguishing control from experimental groups.

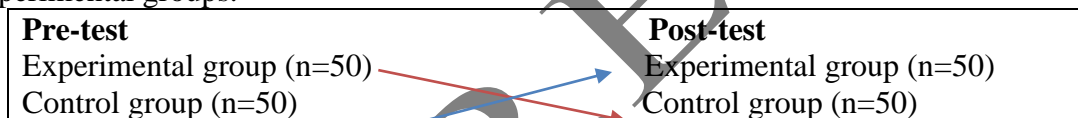


Figure 1. Observational pre-test post-test crossover design

This research project will be conducted in the rural I Lembe District of Kwa-Zulu Natal, South Africa. The study will employ the expertise of fieldworkers, who are postgraduate students involved in the four studies.

The principal investigators have secured I Lembe Royal Court and community leader approval as well as approval from the gatekeeper. A briefing meeting with the participants will be conducted in English and isiZulu (the native language of the community) prior to data collection. At this time, information leaflets regarding the research project and participant informed consent documentation will be dispersed to the community. A communal intermediary will be designated to act as a liaison between the community and the research team. This will ensure that no community members and participants were unduly coerced to participate in the study.

The data collection procedure will occur as follows: completion of the external loading questionnaire, kinanthropometry measurements, electromyographical

recording, and postural assessment during loaded and unloaded phases. The questionnaire documents the association of neuro-musculoskeletal pain with infant carriage, anatomical sites vulnerable to pain associated with infant carriage, how long participants have carried infants, how far they walk with infants on their back and what other chores they complete while carrying the infants on their back. All kinanthropometrical measurements will comply with International Society for Advancement of Kinanthropometry (ISAK) procedures (Stewart et al., 2011). Goniometrical sagittal plane angles that will be measured include the craniohorizontal angle, craniovertebral angle, standing pelvic angle, and tibiofemoral angle. Intra-rater and inter-tester reliability will be ensured to establish the trustworthiness of findings. Electromyographical electrodes will be attached on the neck and hip flexors and extensors so as to determine altered voltage of the postural stabilizing muscles during loaded and unloaded phases. Proprioception will be assessed during loaded and unloaded phases using the Finn protocol on the Biodex System 2 (Motaung et al., 2022). Pulmonary function (FVC, FEV<sub>1sec</sub> and FVC/FEV<sub>1sec</sub>) will be assessed through the use of a portable Easy One spirometry (PURE, 2014:5). Descriptive (means, standard deviations and percentages) and inferential statistics (paired t-tests, chi-squared and Pearson correlation) will be employed in order to compare changes in posture, kinanthropometry, electromyography voltage change, proprioception, and pulmonary function during the loaded versus the unloaded phases. Alpha will be set at  $p \leq 0.05$ .

The eligibility criteria of the study include females who carry infants adopting the traditional African method residing in the Ilembe District, who willingly participate, and who have signed a participant informed consent form (study one, two, and four).

#### **STATISTICAL ANALYSES**

#### **DISCUSSION**

Manual domestic labour is a daily occurrence in rural communities due to limited financial resources (Potgieter et al., 2018; Kurten et al., 2020). The specific

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allocation of tasks to female members of rural communities has and will continue to be defined along the lines of gender-based stereotypes, conforming to the ideology of community leaders (Kurten et al., 2020 &2021). Domestic tasks and responsibilities are allocated among community members following a stringent set of criteria, with certain tasks being allocated to adult males, while other tasks are seen as the purview of female community members, with further tasks allocated to girls, and others to boys (Potgieter et al., 2018). Rural females are assigned domestic activities such as cooking, cleaning, and caring for children and the elderly (Potgieter et al., 2018). Due to limited financial income within rural communities, many nursing mothers are coerced into resuming paid occupational tasks such as cleaning, cooking, and farming, leaving their infants in the care of surrogate caregivers (Mbada et al. 2013). Many of these caregivers are older siblings and grandmothers. Those unfortunate mothers, who do not benefit from this social infrastructure, carry their infants on their backs while resuming the rural responsibilities. Although the posterior infant carriage method is an ingenious method of accomplishing dual tasks simultaneously, it places a burden on the mother and/or surrogate caregiver.

Ojukwu et al. (2017) and Van Eeden et al. (2023) are the only investigation that has been conducted regarding infant carriage in Africa. Ojukwu et al. (2017) study, was undertaken in Nigeria, identified that African females who posteriorly infant carry experience lumbopelvic hip complex pain. Van Eeden et al. (2023) were conducted in South Africa (study one of this project). The present research project seeks to determine whether a similar incidence of neuro-musculoskeletal pain occurs among South African females who also carry infant's posterior. The project furthermore seeks to determine the pathomechanics of the neuro-musculoskeletal pain associated with posterior infant carriage (study one). Additionally, the research project seeks to review the impact of alternative strategies such as front-faced infant carriage on the health and well-being of mothers and surrogate caregivers and establish whether these strategies can alleviate infant carriage neuro-musculoskeletal stress (study two). The present research project will provide evidence which will assist medical doctors, physiotherapists, biokineticists, and



occupational therapists in collectively developing strategies for therapeutic management which will help rural females. There have been empirical investigations confirming that cranial-loading produces lower back and neck neuro-musculoskeletal pain in females who transport food, water, and firewood on a daily basis in rural communities (Ellapen et al., 2009; Motaung et al., 2022). Further to this, the pathomechanics of the aforementioned neuro-musculoskeletal pain has been documented (Echarri & Forriol, 2002; Echarri & Forriol, 2005; Kurten et al., 2022). However, there have been no empirical investigations identifying the impact of combined cranial-loading and simultaneous infant carriage by rural females (study three). This research project will be a novel investigation helping scientists to better document the pathomechanics of the arduous tasks that rural African females perform daily.

**CONCLUSION**

External load carriage, whether cranial-loading and/or infant carriage, is powerfully deep-seated in the cultural beliefs of South African rural societies and is a practice which many community leaders refuse to disavow. As a result, South African rural females will remain bound to their role in carrying external loads. Therefore, by gathering more detailed evidence this study will help scientists, medical doctors, physiotherapists, biokineticists, and occupational therapists in developing new innovative rehabilitation plans to combat the ill effects of cranial loading and back carriage. The primary intention of this research project is to increase the limited empirical evidence regarding the precise pathometrics of the neuro-musculoskeletal pain associated with posterior infant carriage and head loading.

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